Number 19 Series 1925

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In cooperation with the Iowa Agricultural Experiment Station

SOIL SURVEY
OF
KOSSUTH COUNTY, IOWA

BY

T. H. BENTON, in Charge, and D. S. GRAY
Iowa Agricultural Experiment Station
and F. R. LESH, and J. E. McKEEHEN
U. S. Department of Agriculture

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COUNTY SURVEYED

Kossuth County is in the north-central part of Iowa. The Minnesota State line forms its northern boundary. Algona, the county seat, is about 110 miles north and a little west of Des Moines, the State capital. The county measures 24 miles east and west, and nearly 41 miles north and south and has a total area of 983 square miles, or 629,120 acres.

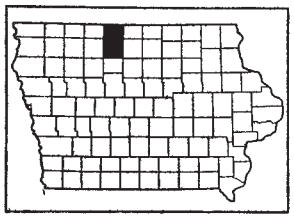

FIGURE 1.—Sketch map showing location of Kossuth County, Iowa

The land surface of Kossuth County is generally flat or undulating, marked here and there by a low hill or ridge, but some areas are gently rolling and a few along East Fork Des Moines River and Black Cat Creek are strongly rolling or broken. The southern part of the county, south of a line from Whittemore through Irvington and passing about 1 mile below both St. Benedict and Wesley, is a smooth drift plain. This part of the county is characterized by a smooth surface and a narrow belt of more strongly undulating land contiguous to some of the drainage ways. Over much of this flat part of the county, the view for miles is obstructed only by a succession of farmsteads. This drift plain is traversed by East Fork Des Moines River.

North of the line mentioned, the elevation is higher, and the land is not so flat, though it is smooth. Only a few small areas are rolling or broken. The surface is marked by numerous flats, depressions, and potholes, and scattered knobby hills, rising from 20 to 50 feet above the general level, are visible for some distance. Several fair-sized streams are in this part of the county.

Drainage in Kossuth County has been determined more by the relief than the relief has been determined by the drainage. The general slope of the plain is to the south, as is also the general course of East Fork Des Moines River. This river, with its tributaries, drains the entire county, except the north-central and northeastern parts, which are drained northward into Minnesota by Blue Earth River and its tributaries. The tributaries of East Fork Des Moines River and their branches do not ramify the entire county and naturally drain only the lands adjacent to them. Many of these streams in their natural state were sluggish and flowed through poorly drained marshes. In many places the streams had no eroded channels whatever. The channels have been dredged and straightened, and the streams now flow along artificial ditches having a good gradient. This dredging, by providing good outlets, has enabled the establishment of a very extensive system of tile drains, and nearly every farm in the county has at least some improved drainage of this type. Union Slough, before it was drained, was a body of marsh

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draining from the north end, near Lakota, into Blue Earth River and from its south end, in section 9 of Portland Township, into Buffalo Creek. This slough is a depression about 12 miles long and varying in width from one-fourth mile to 1½ miles. It is bordered, for the most part, by well-defined banks which in general are precipitous and which are from 20 to 30 feet high. The flood plains of the streams of the county are not wide, in few places being as wide as a quarter of a mile, except along East Fork Des Moines River where in places they attain a width as great as a mile. This river, and to a less extent its larger tributaries, is bordered by level gravel terraces which are more or less continuous from the point where the river enters the county to a point a few miles south of Bancroft and again from west of Irvington to the southern county line.

Native woods in the county grow mainly in the valley of East Fork Des Moines River, particularly below where Black Cat and Plum Creeks enter it. Forests about Algona occur on the strongly rolling areas along the river. The most common trees are basswood, soft maple, locust, boxelder, ash, walnut, elm, hickory, oak, and willow.

Kossuth County in 1920 had a population of 25,082. Of these 88.7 per cent were native-born whites and 11.3 per cent were foreign-born whites, mostly Germans. The rural sections are generally more thickly populated near towns and along the main highways, but there is a fairly even distribution of population through the county as a whole, except in the northern tier of townships and locally in other parts of the county where the lack of drainage in areas of any size has restricted settlement. The larger towns of the county, with their populations are: Algona, the county seat, 3,724; Whittemore, 618; Wesley, 444; Luverne, 610; Burt, 626; Bancroft, 902; and Swea City, 691. Smaller places which afford a shipping point or trading center for the surrounding territory are Hobarton, Galbraith, St. Benedict, Sexton, Plum Creek, Lonerock, Titonka, Lakota, Gerled, and Ledyard.

Kossuth County is well supplied with railroad transportation facilities. The Chicago, Milwaukee & St. Paul Railway crosses the county east and west. The Jewel-Sanborn division of the Chicago & North Western Railway runs north through the county to Burt, whence one branch runs west to Lonerock, Fenton, and points northwest, and another runs north. The Cedar Rapids-Sioux Falls line of the Chicago, Rock Island & Pacific Railway serves the southwestern part of the county and the Minneapolis & St. Louis Railroad the southeastern part. A line of the Chicago, Rock Island & Pacific system crosses the northern part of the county, and a branch of the same system runs east from Titonka.

The main roads of Kossuth County, including both the State and county highways, are well graded and nearly all are graveled. The county-road program calls for the immediate graveling of all main roads, which will afford good roads throughout the year. Some of the less important or township roads are also graveled, but most of them are graded dirt roads.

Telephone service reaches all parts of the county. Country schools occur at regular 2-mile intervals, except in consolidated districts where the school is located centrally with regard to the small schools included in the consolidation.

The towns of the county afford a small market for dairy products, but most of these products are marketed elsewhere. Hogs, cattle, and sheep are marketed largely in Chicago, but to a smaller extent in Cedar Rapids and Mason City. The local creameries, of which there are 13 cooperatives, buy most of the cream produced in the county, although outside cream buyers maintain cream stations in the larger towns. The butter and cheese produced at the local creameries are marketed in New York. A large packing company maintains a branch in Algona, where a large part of the surplus poultry and eggs is sold. Cash grain crops are sold to grain buyers at local elevators.

CLIMATE

The climate in Kossuth County is characterized by comparatively cold winters and warm summers.

The average date of the latest killing frost is May 2 and of the first is October 4. The latest frost recorded was on May 23, and the earliest was on September 15. This gives an average frost-free season of 155 days, which is sufficiently long for maturing the common field crops of the Corn Belt and the varieties of corn which have been adapted to the locality.

The mean annual precipitation of 28.9 inches is favorably distributed, more rain falling during summer than in any other season. The precipitation during the months of harvest is favorable for that work.

Data given in Table 1, compiled from records of the Weather Bureau station at Algona, are representative of Kossuth County.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Algona*

[Elevation, 1,213 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1875)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	21.3	62	−26	0.97	0.27	1.00	6.1
January	14.3	58	−35	.80	1.33	1.50	7.0
February	17.6	70	−36	1.09	.17	6.75	8.6
Winter	17.7	70	−36	2.86	1.77	9.25	21.7
March	30.6	87	−18	1.49	.14	.45	6.8
April	47.0	95	13	2.51	.29	4.00	2.6
May	59.3	96	21	4.13	2.00	4.00	.1
Spring	45.6	96	−18	8.13	2.43	8.45	9.5
June	68.1	98	36	4.44	3.56	10.80	.0
July	73.3	106	44	3.02	.77	2.20	.0
August	70.8	100	37	3.67	2.60	7.10	.0
Summer	70.7	106	36	11.13	6.93	20.10	.0
September	62.2	97	24	3.24	2.83	3.00	Trace.
October	48.8	88	7	2.24	1.18	1.60	.6
November	32.7	74	−17	1.30	.29	.50	4.0
Fall	47.9	97	−17	6.78	4.30	5.10	4.6
Year	45.5	106	−36	28.90	15.43	42.90	35.8

AGRICULTURE

The first settlement in what is now Kossuth County was made at the present site of Algona in 1854. Settlement was slow for some time, especially after the very wet season in 1858 and for some time after the Civil War. The population of the county in 1856 was 284 and in 1865 was 694. Agriculture in this region has always been practically the sole industry.

Early settlement was in timbered areas along streams, where wood could be found for fuel and shelter. Small acreages of land were devoted to the production of subsistence crops. Although Algona was in the center of a rather large settled territory in the northern part of the State, it was outranked in development by other towns at an early date, owing to its failure to get railroad connections as early as some of the surrounding territory and to the fact that a large acreage of the farm land required artificial drainage. This county has since progressed rapidly, however, and at present is a well-developed farming region.

Wheat was the first crop of importance grown by the early settlers, but corn and oats were soon extensively grown. The open prairie afforded a plentiful supply of hay and pasture for livestock. With the coming of the railroads, the county made rapid strides in agricultural advancement, and crops in excess of the local demand were produced. Closely associated with the development of farming was the establishment of artificial drainage on the thousands of acres of fertile land which were not productive because of their poorly drained condition.

By 1880, according to the census, there were in the county 757 farms, with an average size of 146 acres, and the average value of all farm property was $2,894. Only 15.7 per cent of these farms were operated by tenants. Corn had become the crop of greatest importance, overcoming the early lead of wheat. In 1879, 21,058 acres were devoted to corn, with a total production of 635,631 bushels. In the same year wheat was grown on 8,529 acres, and the production was 88,905 bushels. Oats ranked next in importance, being grown on 6,934 acres. Rye, barley, buckwheat, broomcorn, tobacco, and sorghum were less important crops. Potatoes, vegetables, and some fruit were produced on all farms for home use.

According to the census, there were in the county in 1890, 1,635 farms. Tenancy had increased to 23.18 per cent. The population of the county had increased to 13,120, all classed as rural. Corn was still the leading crop, 56,500 acres having been devoted to that crop in 1889, when the total yield was 1,751,085 bushels. Oats were produced on 43,740 acres, wheat on 9,702 acres, barley on 5,944 acres, flaxseed on 3,701 acres, and potatoes on 1,495 acres. There were 112,532 acres in hay.

In 1900 there were in Kossuth County, according to the census. 2,807 farms, averaging 209.2 acres in extent. Tenancy had increased to 37.8 per cent. The average value of all property to the farm was $8,975. Expenditures of $3,200 and $203,260 were reported for fertilizer and labor, respectively. The population of the county had increased to 22,720, 2,911 of which was urban. The value of livestock and livestock products for 1899 was reported as $1,600,402.

The acreages of the important crops had increased greatly. Wheat made the greatest comparative advance, increasing from less than 10,000 acres in 1889 to nearly 58,000 acres in 1899. In 1899 corn was grown on 124,291 acres, oats on 100,921 acres, and barley on 18,133 acres. Less important crops were grown on small acreages. In the same year hay and forage crops were grown on 116,570 acres.

During the following decade, the number of farms decreased to 2,656, and the average total value of all farm property was $17,383. Average farm expenditures in 1909 for those reporting were: Labor, $240.36; feed, $181.46; and fertilizer, $58.67. Only nine farmers reported the purchase of fertilizers. In 1910, 45.4 per cent of the farms were operated by tenants. The total population was 21,971, of whom 2,908 resided in Algona. The total value of agricultural products in 1909, as reported by the census, was $6,764,971, the largest single item of which was the cereal crops which had a value of $3,090,596. Animals sold and slaughtered had a value of $1,815,547. The principal crops and their acreage in 1909 were: Corn, 130,821 acres; oats, 114,290; all tame or cultivated grasses, 46,834; wild hay, 57,958; barley, 3,583; potatoes, 1,918; and flaxseed, 1,064. Other commonly grown crops of minor importance were apples, plums, cherries, bush fruits, and garden truck.

In 1920, according to the census, there were 2,928 farms in the county, with an average size of 196.2 acres and an average value of $49,488 for all property. The population of the county was 25,082, all of which was rural except 3,724, the population of Algona. The density of the rural population was 22 persons to the square mile. Tenancy had increased to 51.5 per cent. The total value of all agricultural products in 1919 was $21,553,387. The most important crops, with their acreage, were: Corn, 160,392; oats, 150,141; tame hay, 36,173; wild hay, 31,796; silage and coarse forage, 17,440; wheat, 3,284; barley, 3,834; potatoes, 1,533; and flaxseed, 1,045. Fruit and vegetables were grown to a small extent on nearly every farm.

The 1925 census reports that in 1924 corn was grown on 212,683 acres, oats threshed for grain on 165,443 acres, oats cut and fed unthreshed on 674 acres, barley on 79,666 acres, and flaxseed on 592 acres. There were in the county in 1925, 2,985 farms, of which 53 per cent were managed by tenants. The average size of the farms was 193.6 acres. The average value of all farm property to the farm was $33,732, and that of the land alone was $127.86 an acre.

Kossuth County at the present time is a well-developed Corn Belt farming region in which corn, oats, hay, and less important crops are produced. In conjunction with the raising of these various crops the feeding and breeding of beef and dairy cattle, hogs, and sheep are carried on.

Corn is the crop of greatest importance in the county. Silver King and various strains of this variety are most extensively grown, but considerable yellow corn, including strains and mixtures of Leaming, Reid Yellow Dent, and Minnesota 13 are also grown. A great deal of corn grown has lost its identity as a specific variety through crossing and individual selection over a period of years. The field selection of seed before frost is becoming a more common practice, especially as in occasional early seasons the frosts catch the corn in an immature state and reduce the average germination to a very low

percentage. Such shortages of seed corn compel the planting of almost any kind of seed of high germination, even though it is an undesirable variety.

The corn is commonly picked from the standing stalks and stored in cribs until it is fed or marketed. Harvesting is done either by hand or, as is rapidly becoming popular, by means of power pickers. Much of the grain that is to be sold is shelled. Some of the crop is hogged down, and some of it is cut with a binder and fed on the stalk from the shock. Soybeans are generally seeded with corn to be hogged down or used for silage.

Most of the corn is fed to livestock. Estimates vary as to the amount utilized in this manner, ranging from 50 per cent to as high as 80 per cent. From two-thirds to four-fifths of the quantity fed is consumed on the farms where it is grown. The remainder is bought by the feeders from neighboring farms which do not produce enough for their own feeding needs. Corn is also the principal cash crop of the county.

Oats is the crop second in importance in the county and is the only small grain which is grown extensively. The varieties commonly grown are Kherson, Albion (Iowa 103), Richland (Iowa 105), Green Russian, and some Iowar and Swedish Select. Considerable of the crop is marketed directly from the threshing machine, and the remainder is stored for use as feed or for sale at a later date. Oats are used largely as horse and hog feed on the farm and are next in importance to corn as a cash crop. Leguminous hay crops are commonly seeded with oats, or some other early small grain, as a nurse crop.

Barley makes excellent feed for hogs and is grown by many farmers for that purpose. It is grown in the same manner as oats. Rye is unimportant in Kossuth County. A small acreage of winter wheat has been sown in recent years by a few farmers. Kanred is the variety most commonly grown, and very satisfactory yields are reported.

Some soybeans are grown, principally with corn which is to be used for silage or for hogging down. A very small acreage is grown for seed, as the local demand is not great. Some farmers feed the hay to hogs.

About 16 per cent of the hay crop, which is raised entirely for local consumption, is made up of legumes, such as red clover, sweetclover, alfalfa, and soybeans. Most of the legume acreage consists of clover and timothy and clover mixed. Some of the land in timothy in the county was originally seeded to a timothy and clover mixture but was allowed to remain in timothy after the clover failed. Red clover and sweetclover are always seeded with oats or some other small grain as a nurse crop, and alfalfa may be seeded this way but is sometimes planted in August on land that has been summer fallowed or that has been plowed after a small-grain crop has been removed. The average yield of tame hay is 1.2 tons to the acre and of wild hay is about 1 ton to the acre. Red clover yields from 2 to 3 tons to the acre and alfalfa from 3½ to 6 tons. Wild hay is cut from wet bottom or upland soils or from unproductive upland, terrace, or bottom soils.

If red clover has made sufficient growth, it is sometimes pastured lightly after the nurse crop is removed. It is of greater importance that the clover be in good condition for the winter than that it be utilized the first year. The following year the first crop is cut for hay and the second crop, which is not so heavy as the first, is utilized in different ways. Some farmers plow it under as green manure. This is a beneficial soil treatment and should be practiced where possible. Others pasture the second growth and then turn under the remaining stubble and droppings of the livestock. This also is a good practice and is next in desirability for soil improvement. The least desirable method of utilizing this second growth is to cut it for hay.

Clover is sometimes grown for pasture. For this purpose it is seeded in the usual manner, with oats as a nurse crop, but the oats is pastured rather than cut for hay or grain. Livestock is turned into the field as soon as the crop will stand pasturing. Alsike is popular for pasture in some parts of the county, but sweetclover and red clover are also used.

Small acreages of alfalfa are grown on a number of farms. Three cuttings are generally obtained, although some growers make four. The fourth cutting is apt to set the crop back so far that it will not have sufficient vitality to live through the ensuing winter. Large acreages of alfalfa do not fit well into the average Corn Belt farm-labor scheme, owing to the frequency of the cuttings and the demand for labor at a time when other farm work is pressing. The first cutting comes during corn-plowing time, the second at the time small grains are being cut, and the third at threshing time. If the alfalfa is not cut at approximately the proper time, the quality of the hay is not so good. This confliction of labor is undoubtedly a contributing cause to the small acreage grown, although the farmers do not fully realize the value of the crop and the benefits to be obtained from growing it.

Potatoes are grown on every farm for home use, and a few farmers raise some to sell in near-by towns. The census reports that the area devoted to this crop in 1925 was 1,371 acres.

Flax is grown by some farmers, particularly on newly broken land on which drainage is poor. It is not grown in succeeding years on the same land and not on land that has previously been cultivated.

Sugar beets have come into prominence in the last few years in Kossuth County and some adjoining counties. They are grown on contract with beet-sugar factories at Mason City and Belmond. In 1924, according to the census, 2,565 acres were devoted to this crop, and the total yield was 24,705 tons. Beet dumps for loading the crop on cars are maintained by the sugar factories in most of the towns in the northern two-thirds of the county. Considerable hand labor is required in raising and harvesting this crop. This work is usually contracted for by Mexican families, who are paid a flat acre rate for the season and receive a bonus for a crop yield that is higher than an accepted standard average. When contracting for acreages, the growers are guaranteed a certain price for their crop, but they receive an additional amount if the price of sugar near harvest time is above a certain figure. This increase is proportional to the price of sugar. The guaranty in 1925 was $5.50 a ton, and the price

actually received was the same. The set labor cost in 1925 was $25 an acre, but it ran as high as $27.50 in some cases where yields were higher. Yields of sugar beets range from 8 to 14 tons to the acre.

All farmers devote a small acreage to the production of garden truck and bush and tree fruits for home consumption.

A very large percentage of Kossuth County is included in drainage projects, and few farms are not affected to some extent by artificial drainage. The establishment of artificial drainage has produced remarkable improvements and benefits and has converted thousands of acres of poorly drained soils into highly prized and productive farm lands. A large part of the artificial drainage system of the county consists of tile drains and open ditches. Some of these ditches have been dug through sections where no drainage existed before, and others follow the general courses of former sluggish streams which were little more than a movement of water through sloughs or depressions. Open ditches and county tile lines have been placed at sufficiently close intervals to provide an outlet for individual-farm tile systems. The laying of tile in the average poorly drained soil costs from $25 to $35 an acre.

The breeding and feeding of hogs is the most important livestock industry in the county. Every farmer raises some hogs, the number on farms ranging from 50 to 300. Sows are bred for both spring and fall farrowing. The total number of hogs on farms in 1924 was 136,218. Of this number 31,658 were breeding sows 6 months old or older. The most popular breeds of hogs are Poland China, Duroc-Jersey, and Hampshire. Market stock is fed until it weighs from 250 to 350 pounds, the weight depending on the trend of the market and the ideas of the individual feeder. About 3,000 carloads of hogs were marketed from the county in 1924. The chief markets are Chicago, Mason City, and Cedar Rapids.

The raising and feeding of beef cattle is an important industry in the county. The breeds represented are Shorthorn, Hereford, milking Shorthorn, and Angus. There are not a great many purebred herds in the county, but many of the grade animals are well bred. A rather large number of feeder cattle is shipped in each year. Many of these are purchased on the Sioux City and Omaha stock markets, although some are supplied by a local dealer who buys on the western range. This stock is ordinarily fed about 120 days, although some herds are fed for five or six months. There were 14,628 beef cows in the county in 1925. About one-third of the cattle and hogs of the county are marketed through cooperative livestock-shipping associations. The principal markets for cattle are Chicago, Mason City, and Cedar Rapids.

Sheep are not important in the county, and few are kept for breeding purposes. The total number on farms on January 1, 1925, was 3,383, according to the census, and the wool clip in 1924 was 22,565 pounds.

Horses are in use on all farms, and in 1925 there were 20,846 head in the county. There are only a few horse breeders in the county, but most farmers raise a colt or two each year for their own use. The average mature horse weighs from 1,400 to 1,700 pounds, although a few breeders raise heavier stock. There were 829 mules in the county in 1925.

Dairying is a very important industry in Kossuth County. The 13 cooperative creameries in the county transact a large volume of business each year. Most of these produce high-quality sweet-cream butter, under the Iowa testing and scoring system. Most of the surplus butter is shipped to New York. The creamery in Algona also operates a city milk route. There were 12,871 dairy cows and 2,531 dairy heifers, 1 year old and under 2, in the county in 1925. The Holstein is the most popular breed, although there are a few good Jersey and Guernsey herds. Many of the dairy cows are grade animals. The total number of cows milked in 1924 was 20,424, including 8,830 beef cows.

All farmers raise some poultry. On January 1, 1925, there were 513,929 chickens on the farms. Some ducks, geese, and turkeys are raised. In 1924 the egg production is reported as being 2,061,369 dozens. Practically all breeds of chickens are represented. Some flocks are large, but on most farms poultry raising is a side line.

A rather large percentage of the livestock and dairy products of the county is marketed through cooperative agencies, such as the cooperative creameries and the livestock-shipping associations. Little cream is sold in the county except to the cooperative creameries. It is estimated that about 33 per cent of the livestock is marketed through cooperative shipping associations, which saved the farmers of the county between $25,000 and $30,000 in commissions in 1924.

Although the general field crops are grown on nearly all the soils of the county, some recognition is given to the characteristics of the different soils. The very rough or very wet soils are recognized as not being adapted to cultivated crops and are used for pasture, wild-hay land, or timberland. The heavy black soils are cropped most heavily to corn. Tame hay and legumes and small grains are grown on the rolling soils, in addition to corn. Sugar beets are believed to grow best on the flat Webster soils of the upland, but beets of a high sugar content may be grown on the Clarion soils.

Modern equipment, including 1, 2, and 3 bottom plows, disks, harrows, 1-row and 2-row corn plows, and binders is in common use by nearly all farmers. Corn-picking machines are rapidly coming into more common use. The 1925 census reports 842 tractors on farms in that year. Farm buildings are generally well built and adequate for the housing of crops, livestock, and machinery. The improvements in Kossuth County are, as a whole, among the best in the northern part of Iowa.

When possible, land is plowed in the fall. Oats are seeded on disked corn stubble. Manure is the most common fertilizer in use, but the supply is insufficient for the needs of the soil. Commercial fertilizer is used to a small extent. The total reported expenditure for fertilizer, including lime, in the county in 1924 was $9,276.

The farm labor is chiefly local, although a few laborers from near-by towns work during the harvest season. The greatest demand for outside labor is in the sugar-beet fields, where many Mexicans are employed. The monthly wages for general farm work are $35 or $45, and daily wages are from $2.50 to $4, depending on the type of work to be performed.

Local estimates place the number of farms rented on a cash basis as being 55 per cent and on the share basis about 45 per cent of

the total number rented. The prevailing cash rent is $8 an acre or less. Share rents vary, but generally the owner receives two-fifths of the small grain and half the corn. Hay and pasture land are rented for $5 or $6 an acre.

Land values range from $125 to $200 an acre for the better soils. Large acreages sell for less, and a few farms have sold for more than $200 an acre. The average valuation in 1925, for purposes of taxation, was $60.42 an acre.

SOILS

Two major factors determine the characteristics of a soil. The first is the nature of the parent material and the second includes the processes of soil development, such as weathering, leaching, oxidation, and aeration. These are all processes to which the original soil material has been subjected as the soil has developed into its present state. It is now known that the soil-forming processes are more responsible for the important characteristics of the soil as it is found to-day than is the parent material.

Kossuth County lies in the prairie region of the United States where a rather high precipitation and moderate temperatures promoted a very rich and luxuriant growth of prairie grasses. The decay, through centuries, of grass roots has resulted in a large content of organic matter in the surface layers of all the soils of the county, and this has imparted to them a black or nearly black color. The thickness of the black surface layer at any place and the intensity of its color are influenced directly by the drainage of the soil, and this factor is determined by the surface relief and the character of the substratum.

Two divisions may be made in the dark-colored soils of the county on the basis of characteristics produced by drainage. On the well-drained areas the soil-forming processes have acted without interruption and have produced the normal profile for this region, but conditions of excessive moisture, where present, have retarded soil development, and immature or abnormal soils result.

Probably half of the upland soils of the county and all the bottomland soils have developed under conditions of poor drainage. This has resulted in the formation of very dark-brown or black surface soils, 15 or 20 inches thick, underlain by drab, gray, or mottled drab, gray, and brown heavy-textured subsoils. Under such conditions the Webster, Fargo, and Lamoure soils, which still retain sufficient lime to effervesce with acid within 3 feet of the surface, and the members of the Wabash series, which have been leached of their lime and other carbonates to a depth of more than 3 feet, have been formed.

The most important of the immature soils of the county are the members of the Webster series, which is represented in this county by the loam and silty clay loam members. The surface soils range from mellow, friable, very dark grayish-brown or black loam to silty clay loam of the same color. The subsoils, which occur below a depth ranging from 15 to 20 inches, are gray or drab silty clay or clay. The parent material is gray or whitish, friable, calcareous clay.

The other immature soils of the county also have black or nearly black surface soils overlying gray or drab clay subsoils which are in places mottled with yellow and brown. They differ from each other only in their content of lime and in topographic position.

The Wabash soils, which occur on first bottoms, are noncalcareous, and have surface soils which range in texture from loam to silty clay loam. Wabash loam, Wabash silt loam, and Wabash silty clay loam are mapped. The Lamoure soils, which also occur on first bottoms, differ from the Wabash only in that they are calcareous. Lamoure silt loam and Lamoure silty clay loam are mapped. Fargo silty clay loam, the only member of this series mapped, is similar in appearance to the Lamoure soils but occurs on terraces above overflow.

Other extensive areas of dark-colored soils have developed under conditions of good surface soil and subsoil drainage. Representative of this group are members of the Clarion series, of which the loam, with a rolling phase, and the fine sandy loam are mapped. The surface soils of these soils are typically dark colored to a depth ranging from 8 to 14 inches, and in the virgin state are finely granular in structure. The next lower layer is lighter brown than the surface soil, is heavier in texture, and contains clay particles translocated from the surface layer. This material has a finely granular or small nut structure. It is underlain by the substratum at a depth varying from 18 to 36 inches but averaging about 24 inches. The material of this layer is a buff, yellow, or grayish-yellow, friable, mellow, highly calcareous aggregation of bowlder clay, and is the parent material from which the soil was derived. Although its high content of lime renders the substratum friable and mellow, it is by no means open or porous. It is very retentive of soil moisture but allows sufficiently good drainage to give adequate aeration.

Other soils of the county coming within this group of dark-colored well-drained soils are those of the Sioux series, which also contain lime within 3 feet of the surface, and the Dickinson, Buckner, and Hancock soils, which have been leached of their carbonates to a depth of at least 3 feet.

The surface soil of members of the Dickinson series is loose, friable fine sandy loam. The subsurface soil is sandy, is lighter brown in color, and is single grained in structure. The subsoil consists of incoherent sand. Dickinson fine sandy loam is the only member of the Dickinson series mapped in this county.

Hancock loam, the only member of this series mapped in Kossuth County, is a terrace soil which has a dark-brown, finely granular surface soil and a heavier-textured brown or yellow subsoil.

The surface layers of the Sioux soils are dark brown or very dark brown and range in texture from loam to fine sandy loam. They have a finely granular structure. The subsurface soils are lighter-brown sandy loam or loamy sand, and the subsoils are yellowish-brown or yellow incoherent sand and gravel. Sioux fine sandy loam and Sioux loam are mapped.

The Buckner soils have deep, dark-colored, fine sandy loam surface soils which have no apparent structure. The subsoils are friable sandy loam, admixed with coarse sand. Buckner fine sandy loam represents this series in Kossuth County.

In addition to the influence of the soil-forming processes, the character of the original parent material from which the soils have been derived is taken into consideration in separating the soils into series. There are but two types of parent material in Kossuth County, the glacial drift which covers the upland and the alluvial

material along the streams. The latter includes the terraces or former flood plains of the streams, which are now above overflow, the present flood plains, which are subject to inundation at times of high water, and in a few places sloughy upland areas which are covered with water following heavy rains or melting snows. This alluvium is reworked glacial material removed by erosion and redeposited by water action. The surface covering of Kossuth County, which is débris of the Wisconsin glaciation, is the most recent drift deposit in the State. The newness of this material is shown by the unleached condition of the richly calcareous soils and by the lack of extensive and well-developed natural drainage systems. The soils of the Clarion, Webster, and Dickinson series have developed over the drift.

The alluvial soils of the county are of two types, the older and the more recent. The older alluvial soils, which occur on flat terraces from 5 to 20 feet above overflow, are largely underlain by gravel or sand and gravel material deposited by the torrents of water released by the receding and melting glacier. A small percentage of the terrace soils have a heavier-textured subsoil than that described and are more retentive of moisture. The more recent or younger alluvial lands of the county are represented by the first bottoms along streams and by a few depressed, sloughy upland areas which are subject to inundation at wet seasons. These newer alluvial soils have uniformly dark-colored surface soils and gray or drab heavy-textured subsoils.

The glacial drift in position or reworked has been modified by weathering processes combined with plant growth, into the highly developed and complex substance which we now know as the soil. The soils of the county are classified into series on the basis of their origin, color, structure, lime content, and other physical and chemical properties and into soil types on the basis of the texture of the surface soil.

In the following pages of this report the various soil types are described in full and their agricultural importance is discussed; their distribution is shown on the accompanying map; and their acreage and proportionate extent are given in Table 2.

TABLE 2.—*Acreage and proportionate extent of the soils mapped in Kossuth County, Iowa*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Clarion loam	243,328	40.1	Wabash loam	256	0.1
Rolling phase	9,024		Wabash silt loam	4,992	.8
Clarion fine sandy loam	1,600	.2	Wabash silty clay loam	8,512	1.4
Webster silty clay loam	174,592	27.8	Lamoure silt loam	1,600	.2
Webster loam	148,736	23.6	Lamoure silty clay loam	12,672	2.0
Dickinson fine sandy loam	1,472	.2	Peat	3,136	.5
Sioux fine sandy loam	8,320	1.3	Muck	7,296	1.2
Sioux loam	1,408	.2	Gravel pits	64	.1
Fargo silty clay loam	576	.1			
Buckner fine sandy loam	896	.1	Total	629,120	
Hancock loam	640	.1			

CLARION LOAM

The 2-inch surface layer of Clarion loam consists of dark grayish-brown silty loam. Numerous grass roots hold this layer together as a turf. The next lower material, to a depth ranging from 7 to 10 inches, is very dark grayish-brown loam, which when wet appears black. The structure of this layer is finely granular, but the granules are soft and indistinct. The third layer, which continues to a depth of about 24 inches, is transitional in color, grading from very dark grayish-brown in the upper part of the layer to brown in the lower part. The structure of this material is distinctly granular, and the granules are larger than in the layer above, being about one-fourth inch in diameter. The dark color is caused by the black organic matter which has penetrated from the surface layers and which forms a coating over the granules and follows cracks, root holes, and worm and insect burrows. The texture of this layer is slightly heavier than that of the layer above. The next lower layer is grayish-yellow, mellow glacial drift. It is without structure and breaks up in soft irregular clods. It is composed chiefly of clay but contains some sand and a few pebbles of various sizes. Limestone pebbles and lime-rock flour present indicate that this layer is highly calcareous.

Cultivation has not greatly altered the profile of Clarion loam. The only differences are that the native sod has been destroyed and that the structure of the surface soil is more pronouncedly single grained.

Included with this soil in mapping are local variations, occurring on smoother areas or at the base of slopes in the more rolling areas, in which the surface soil is darker and deeper than typical. The subsoil in these areas is in many places stained with iron or slightly mottled below a depth of 30 inches. In other places the surface soil is thinner and lighter than typical. Such areas occur on the crests of hills or ridges in areas where the relief is greatest. In the northern three-fourths of the county the areas of this soil are broken by the presence of small gravel pockets. These vary from 20 to 100 feet across and in depth from 2 to 10 feet. Many of them have been opened and a part or all of the gravel removed. Such areas are indicated on the map by a gravel-pit symbol. Undisturbed deposits are indicated by gravel symbols. In undisturbed gravel pockets the surface soil is dark-brown gravelly sandy loam from 6 to 12 inches thick.

Clarion loam is the most extensive soil mapped in Kossuth County. It occurs throughout the county but less extensively in the southern part on the flat drift plain, where it is mapped in narrow strips contiguous to drainage ways or as isolated rises from 10 to 100 acres in extent. Through the rest of the county it occurs in irregular, tortuous-shaped areas, closely interlaced with members of the Webster series, particularly with Webster loam. So general is the occurrence of this soil that few, if any, sections or even quarter sections of land in the northern three-fourths of the county do not contain at least a small area of it.

The surface relief of this soil varies from strongly undulating, in small areas adjoining or surrounded by the Webster soils, to gently rolling or rolling in continuous or larger areas. Patches of the soil surrounded by members of the Webster series occupy smooth, even rises standing out of a flat or level area. Elsewhere, in larger areas,

the soil may present a continuously rolling relief. Areas lie in gently rolling swells and are all suitable for cultivation.

Natural drainage, as would be expected on land with such relief, is good but not excessive. In places tile lines are laid down the center of a narrow swale or depression. Otherwise natural drainage is adequate.

Clarion loam is the most important soil in the county, both because of its great extent and because it is naturally a good, fertile soil which is highly productive under good management.

Corn is the crop of greatest importance on this soil. Yields range from 40 to 65 bushels to the acre, depending on crop rotation, tillage, seeding and seed selection, the use of manure, and to some extent on the fertility and drainage of the soil in particular areas. Oats yield from 30 to 60 bushels, clover 2½ tons, alfalfa from 3 to 5 tons, sugar beets from 7 to 10 tons, and tame hay 1½ tons to the acre. Winter wheat is grown with satisfactory results by a few farmers north of Algona. Yields range from 20 to 30 bushels to the acre. Kanred is the most popular variety at the present time.

Clarion loam is handled by the general methods prevailing through this section of the country. Plowing is done in the fall after small grain has been harvested, or on corn-stubble or cornstalk land in the spring when the succeeding crop is to be corn. No regular or systematized rotation system is in common use. Corn is grown two years in succession and is followed by oats. Frequently the land is then returned to corn, unless clover and timothy are grown with the oats. Some farmers leave the land in hay for a season or two after the clover is exhausted, but this is not a common practice. Some farmers have a more or less continuous hay lot or cut wild hay from some piece of land which is not suitable for cultivation. Available manure is applied to the land, but few farmers feed sufficient livestock to have enough manure to cover the average farm once in four years with a good application.

Probably 10 per cent of the farmers endeavor to follow a more or less regular crop rotation, such as corn, oats, and clover. Commercial fertilizers are not in common use, but some have been used with varying degrees of success. They should be tested by the individual farmer before using them on a field scale. A few farmers plow under legume crops as green manure. Clarion loam, with good farming methods, crop rotation, the growth of legumes, and the use of manure and green manures can be made to produce consistently high yields without any material depletion of its fertility. At least such depletion will proceed at a much slower rate than under the system of management now practiced on many farms.

The current value of this soil depends on such factors as location, improvements, and state of cultivation. Well-improved farms located on a gravel highway or paved road near a town have been selling for $200 or $225 an acre, but the average fairly well-improved farm on this soil, with a fair location, commands from $160 to $200 an acre. Areas in the extreme northern part of the county and in certain other unimproved localities have a lower value than in the county as a whole.

Clarion loam, rolling phase.—The surface soil of the rolling phase of Clarion loam is dark grayish-brown, finely granular, friable loam. This is underlain, at an average depth of 9 or 10 inches, by a layer of

higher clay concentration. This layer is somewhat transitional throughout, presenting a gradual change from the dark grayish-brown color of the surface soil to yellowish brown just above the parent material. In texture it ranges from heavy loam just below the surface soil to silty clay loam near the bottom of the layer. It contains some gritty material and a few small bowlders, but not in sufficient quantity to modify the texture. In structure it is coarsely granular. The parent material, below a depth ranging from 16 to 20 inches, consists of buff-colored, friable pebble drift clay. It is highly calcareous and contains limestone pebbles, rock fragments, and limerock flour.

Locally this soil may show some variations from the typical profile. In places the texture of the surface soil approaches fine sandy loam, and some small gravel spots, such as occur in typical Clarion loam, are present. The most notable profile difference in this soil occurs in a small area on both sides of East Fork Des Moines River, just south of Algona. Here the color of the surface soil is more gray, and the subsurface soil is more tough and impervious than typical. This area is in timber, which probably explains the lighter-gray color.

This phase of soil is of small total extent in Kossuth County. It occurs in narrow areas along East Fork Des Moines River and some of its larger tributaries. Small areas are also in the vicinity of Goose Lake and Burt Lake in Eagle Township.

The surface of this soil is rolling, strongly rolling, or broken. The greatest relief occurs in the areas on both sides of East Fork Des Moines River, south, a little southwest, and southeast of Algona. Elsewhere steep areas may occur in places, but most of the soil is strongly rolling. Timber, probably of comparatively recent growth, covers a part of the strongly rolling land.

Drainage is good or excessive. Although some of this soil is cultivated it is not generally smooth enough for such utilization and is used mainly for pasture and timber. When plowed it is subject to damaging erosion. A very few small areas are sufficiently smooth to be put under the plow. Crop yields on cultivable areas are much lower than on the typical soil.

Where cultivation of this soil is imperative, great care should be observed in its management. Contour plowing and cultivation should be practiced wherever possible to assist in the prevention of erosive action. A crop rotation, such as corn, oats, and clover, should be followed to maintain the organic-matter content and increase the water-holding capacity of the soil, thereby decreasing the movement of surface water and subsequent erosional action. The use of liberal quantities of both barnyard and green manure is strongly advised.

Table 3 shows the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of Clarion loam.

TABLE 3.—*Mechanical analyses of Clarion loam*[1]

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
336601	Surface soil, 0 to 14 inches	2.0	5.2	7.7	18.5	11.3	25.0	30.3
336602	Subsurface soil, 14 to 24 inches	3.1	5.6	7.1	16.8	10.5	26.3	30.6
336603	Subsoil, 24 to 36 inches	5.8	9.1	10.5	22.7	13.2	23.6	15.0

[1] After treatment with hydrogen peroxide.

CLARION FINE SANDY LOAM

The surface soil of Clarion fine sandy loam, to an average depth of 12 inches, is dark grayish-brown or very dark grayish-brown friable fine sandy loam. The subsoil, which consists of brown or yellowish-brown loam, heavy loam, or silty clay loam, resembles that of Clarion loam but, on an average, probably contains more sand. Generally, however, this layer is heavier than the one above, indicating some translocation of some finer soil particles. The transition from this layer of translocation to the parent material, which occurs at a depth of about 22 inches, is somewhat gradual. The parent material is yellowish or buff-colored calcareous drift clay. Some sand and a few pebbles are present, as well as considerable limerock flour and limestone pebbles or fragments of limestone rock. No great difference was distinguishable between the virgin and cultivated areas of this soil. As in the other Clarion soils, gravel pockets occur in this soil.

Clarion fine sandy loam occurs in a few small scattered areas over the county. The largest areas occur in sections 19 and 20 and in sections 14 and 15 of Grant Township.

The surface of this soil is undulating, gently rolling, or rolling. Natural drainage is good and, in places, may be excessive. In surface relief most of the soil is suitable for cultivation, but it is not of great importance in Kossuth County because of its small total extent.

The common field crops, particularly corn and oats, are grown on the cultivated areas of Clarion fine sandy loam. Part of the soil is pastured, but none of it is in timber. Corn yields are about 25 per cent less than on Clarion loam.

The greatest deficiency of this soil is probably in humus. This material could be supplied to good advantage by the use of either barnyard or green manure crops. By following a crop rotation including a legume, by applying manures, and by following good tillage practices, satisfactory yields of crops should be obtained on this soil. The land should be plowed to a depth of about 7 inches.

This soil is always sold in conjunction with other soils.

Table 4 shows the results of mechanical analyses of samples of the surface soil, subsurface soil, and two layers of the subsoil of Clarion fine sandy loam.

TABLE 4.—*Mechanical analyses of Clarion fine sandy loam*[1]

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
336651	Surface soil, 0 to 8 inches	1.9	4.1	6.2	22.8	16.8	27.4	20.9
336652	Subsurface soil, 8 to 20 inches	1.6	3.4	5.4	19.2	15.8	28.2	26.4
336653	Subsoil, 20 to 30 inches	.4	1.6	4.6	23.6	24.9	26.6	18.2
336654	Subsoil, 30 to 40 inches	1.3	2.5	3.7	15.7	15.2	35.0	26.4

[1] After treatment with hydrogen peroxide.

WEBSTER SILTY CLAY LOAM

The surface soil of Webster silty clay loam, to an average depth of about 17 inches, is black silty clay loam. In the virgin soil, the 3-inch surface layer is filled with grass roots, forming a turf. The

structure of the surface soil is finely granular, but the granules are not distinctly formed and loose silt is present in the dry soil. This layer is underlain, to a depth of about 28 inches, by plastic silty clay loam or silty clay. A dark-gray color predominates, but light-gray spots and streaks are common. Small glacial gravel and bowlders are commonly abundant in this layer, but not sufficient lime is present to effervesce with acid. The next lower layer, continuous to a depth of about 42 inches, consists of silty clay loam which is grayish yellow or gray mottled with light gray or yellow. Lime is abundant and occurs both evenly disseminated through the material and in small soft concretions. Small glacial bowlders and pebbles occur at all depths in this layer. This material, which is little altered by weathering, is the glacial drift from which the soil is derived. The next lower layer, which reaches a depth of more than 6 feet, is highly mottled gray, brown, and yellow glacial drift. Small iron concretions may be seen, and iron stains discolor more than half this material. The lime content is high, and the lime occurs in much the same form that it does in the layer above. This material has a silty clay texture and is plastic.

The texture of the surface soil varies from heavy silt loam to silty clay, though in most of the areas mapped as Webster silty clay loam it is silty clay loam. Small silty areas occur in nearly all parts of the county, but most extensively southwest of Algona. These areas are flat and lie at a slightly higher elevation than typical Webster silty clay loam. The silty clay areas occur in many of the lower areas of Webster silty clay loam. The texture of such areas is slightly heavier than that of the typical soil. The gradations between these areas of varying texture are almost imperceptible, and as the soils have many features in common it was considered inadvisable to attempt to separate the areas in mapping. A few included swampy areas have been indicated on the map by means of swamp symbols.

Webster silty clay loam occurs most extensively in the southern part of the county on the flat drift plain. It occupies a large part of Whittemore, southwestern Cresco, Garfield, Riverdale, Sherman, Luverne, and southern Irvington and Prairie Townships. In places it extends from section to section as a narrow, tortuous area, possibly depressed, and in others it broadens out into an unbroken area covering several square miles. The unbroken areas lie on a broad, flat, smooth plain. In the northern three-fourths of the county this soil occurs in areas varying from flat table-lands to round, elongated, or variously shaped depressions within areas of Webster loam or the Clarion soils and in places in depressions following swales or well-defined drainage ways. In a few places it occurs along ditched streams as first-bottom land. In such areas, however, the subsoil is true drift and occurs within 3 feet of the surface. It is probable that in such areas the soil to a depth of 1 or 2 feet may be alluvial material that rests on drift clay at a depth less than 3 feet.

Natural drainage on Webster silty clay loam is deficient, and for profitable crop production tiling and open-ditch drainage systems are necessary. Natural drainage on the flat table-land areas is better established than on the lower areas and in years of light precipitation may be adequate for crop production. Natural drainage, how-

ever, is uncertain in all areas. Depressed areas which receive some surface water from the surrounding higher ground are the most poorly drained.

Poor drainage is the greatest limiting factor in crop production on this soil. Tile drains, as well as occasional open ditches, are necessary. In such soil as this, the laterals in a tile drainage system would need to be comparatively close together to provide a sufficiently rapid removal of surface water.

Webster silty clay loam is important because of its high fertility and its extent, particularly in the southern part of the county. Even after good drainage has been established, the soil must be worked carefully and at the proper time, because of its heavy texture and its tendency to puddle or clod.

Corn is the outstanding crop produced on this soil, which is probably the most heavily cropped corn soil in the county. Yields vary from 40 to 80 bushels to the acre, with the development of drainage and the care with which the soil is managed. No special varieties of corn are grown on this soil. After corn has been grown for several years, some small grain, such as oats, barley, rye, or wheat, is grown. Short strong-stemmed varieties of small grain are most desirable, as the ranker varieties are apt to lodge badly on this soil. Of the oat varieties Richland (Iowa 105) and Albion (Iowa 103) are the most popular. Oats yield from 35 to 70 bushels to the acre. The other small grains are not grown to any extent. Some clover is grown, and yields ranging from 2½ to 3½ tons to the acre are obtained, but most hay grown on this soil is timothy or wild hay. Alfalfa does well when it is properly seeded. Any acidity of the surface soil should be corrected by the use of limestone, and the seed should be inoculated to insure a successful stand.

Most of this soil occurring in the southern part of the county is under cultivation, although there are a few virgin areas. A smaller proportionate acreage of the soil is under cultivation in the northern three-fourths of the county than in the southern part. A rather large proportion of the soil in the northern part of the county is in pasture or wild-hay land, probably largely because drainage is poor. The soil supports no natural timber growth, although groves and orchards are successfully grown on farmsteads.

When corn follows corn, this soil is plowed in the spring unless the corn has been cut for silage or cut and stacked early enough in the fall to permit plowing at that time. Oats are seeded on disked corn-stubble land, and if clover or alfalfa is also to be grown it is seeded at the same time. Timothy is generally included in tame-hay mixtures, which are generally left on the fields for two years. Some sugar beets are grown and satisfactory yields are obtained.

Commercial fertilizers are not in common use except on sugar beets. Manure is the chief fertilizing material, but sufficiently large quantities are not available. The physical condition of the soil is impaired through continuous cropping to grain. For the addition of organic matter and the improvement of the soil in indirect ways some leguminous crop should be included in the rotation. This could be seeded every five or six years, allowing a greater production of grain than on some of the lighter soils of the county without so detrimental an effect on the producing power of the soil. A part of this legume

crop, such as the second or last growth, could be plowed under as green manure. Even if the second growth of the clover crop were pastured and the livestock droppings and remaining stubble growth were turned under, some lasting benefit would be obtained. Removing both crops for hay is an undesirable practice from the standpoint of improving the soil.

This soil, with improvements including good tile drains, has a value ranging from $125 to $200 an acre. Some farms with particularly attractive features have brought as high as $225. Unimproved the soil is worth from $80 to $125 an acre. In some respects this soil is less desirable than others with lower potential fertility. Properly farmed, well-drained areas are wonderfully productive, but less desirable areas carelessly handled produce low yields. Poorly drained, depressed areas, such as some occurring in the northern part of the county, have a value ranging from $50 to $70 an acre.

WEBSTER LOAM

The surface layer of Webster loam, to a depth ranging from 6 to 12 inches, is very dark grayish-brown or nearly black mellow loam of rather finely granular structure. The subsurface layer is of similar color but of slightly heavier texture, ranging from heavy loam to heavy silt loam, or, in some places, even to silty clay loam of finely granular structure. The subsoil, which occurs below a depth averaging about 15 inches but ranging from 12 to 18 inches, is the zone of translocation. It consists of drab clay containing faint gray mottles and a few iron stains. This layer terminates at a depth averaging approximately 26 inches but varying from 23 or 24 inches to 30 or 34 inches and, in a few places, to 36 or 40 inches. The unmodified parent drift is calcareous gray drift clay, densely mottled with brown and yellow and richly stained with iron and incipient concretionary material. Limerock flour and limestone pebbles occur throughout this layer. In cultivated areas the surface soil is more friable, is single grained in structure, and contains more noticeable sand to a depth of a few inches. The sand is medium in grade and is thought to be partly wind blown.

This soil ranks next to Clarion loam in importance. It occurs over the entire county but more extensively in the northern three-fourths, where it is found both in rather extensive areas and as small, irregular, tortuous tracts associated with Clarion loam. Some of the elongated areas occurring between areas of Clarion loam consist of depressions between rises and have a gradual slope from the Clarion loam to the center of the area of Webster loam. In some places the exact location of the boundary is somewhat arbitrary, as the transition from one soil to the other is very gradual. In some such places a very narrow strip of heavy-textured Webster silty clay loam may be present in the lowest part of the depression or its center. These strips are generally of insufficient size or width to be of material importance, and it is impossible to show them on a map of the scale used in this survey.

Natural drainage is in most places fair but may be deficient. In some of the higher areas it is adequate. It is poorest in areas surrounded by soils occurring at a higher elevation. There is a rather

intricate interlacing of Webster loam and Clarion loam in many places in the northern three-fourths of the county. The relief in such places is billowy and uneven.

Webster loam is a very productive and highly desirable soil. Although requiring some artificial drainage, it is more easily handled than Webster silty clay loam. It probably requires little, if any, more draft for field operations than Clarion loam. The surface soil contains sufficient sand to make it friable. This allows working under a wider range of moisture content than is possible on Webster silty clay loam.

A very large percentage of this soil is under cultivation to the common field crops, principally corn, oats, and hay. Crop yields are from 10 to 20 per cent higher, on adequately drained areas, than on Clarion loam. Corn yields from 50 to 75 bushels to the acre, depending on management and cropping methods; oats from 45 to 70 bushels; alfalfa from 4 to 6 tons; clover from 2½ to 3 tons; and winter wheat from 22 to 30 or 35 bushels. In very favorable seasons, higher yields are obtained on particularly well-managed farms. A rather large acreage of sugar beets is grown on Webster loam. Yields of this crop range from 8 to 15 tons to the acre.

Webster loam is managed in about the same way as is Clarion loam. The land is plowed to a depth ranging from 4 to 6 inches, in the fall if possible. Some barnyard manure is applied, but green manures are not in common use. Corn is generally grown two or more years and is followed by a small grain, generally oats. Most of the soil is then returned to corn, but some is seeded to a leguminous hay crop, such as clover mixed with timothy.

Although the fertility of this soil is comparatively high, the use of manures has proved very profitable. They not only add plant food to the soil but improve the physical condition. Sufficient manure is not produced on the average farm to maintain the desired state of fertility. This suggests the growth of leguminous crops for total or partial use as green manure, as a means of maintaining the content of organic matter and nitrogen in the soil. Crop residues are also valuable for this purpose, and as much of the cornstalks and small-grain straw as possible should be plowed under. Commercial fertilizers are of questionable value on a soil in as high a state of natural fertility as is Webster loam. Their effects should be tested on a small acreage before they are applied on a large scale. Good tillage practices, including plowing to a depth of 6 or 7 inches and thorough cultivation, are essential in a desirable system of soil management for this soil. The proper management for some areas affected by alkali is described in the chapter on alkali.

Land values range from $150 to $225 an acre for drained and improved farms, depending on the location and state of improvements. Some more poorly drained areas or areas associated with poorer soils command a somewhat lower price. In conjunction with desirable areas of Clarion loam and Webster silty clay loam prices range from $175 to as much as $215 an acre.

DICKINSON FINE SANDY LOAM

The surface soil of Dickinson fine sandy loam is friable dark grayish-brown fine sandy loam to a depth averaging 10 inches but ranging from 6 to 14 inches. Its structure is single grained, as is that

of the succeeding layers. The subsurface soil, to a depth of about 2 feet, is brown or yellowish-brown fine sandy loam or loamy fine sand. It is underlain by brownish-yellow incoherent fine sand. In cultivated areas the surface soil is a little lighter colored. A few small areas vary from typical in that the subsoil contains considerable gravel along with the sand. This gravelly material is in places calcareous.

Dickinson fine sandy loam occurs as small, isolated areas, generally on slight eminences rising out of areas of Clarion loam. The relief is smoothly rolling or rolling. Because of the openness of the subsoil, natural drainage is generally excessive, except in years of plentiful moisture.

The general farm crops of the county are grown on this soil. Some of the soil is left in pasture, or wild hay is produced on it. Most of it occurs as isolated areas surrounded by better soils, and special attention is not given it. The principal crops grown are corn, oats, and hay. Yields are variable but are prevailingly low. Corn yields from 20 to 35 bushels to the acre, oats from 20 to 30 bushels, and hay from one-half to 1 ton.

Dickinson fine sandy loam is not important because of its small extent and moderate productiveness. It causes low-yielding spots in fields that are otherwise much more productive and should be given special consideration. This soil is poor both in water-holding capacity and in plant food. Commercial fertilizers are not in use. Considering the occurrence and size of the areas, it is probable that the best means of improvement is through good farm practice. Frequent applications of manure in the proper amounts would prove very beneficial. If barnyard manure is not available, the organic-matter content may be maintained through the growth of legumes. The success of legumes, except perhaps red clover, would be uncertain unless acidity were corrected and the seed inoculated. A test on one area of the soil, in which the degree of acidity in the subsoil was medium, showed the acidity to be such that limestone at the rate of 2½ or 3 tons to the acre was required. Plowing under a large part of the legume growth would prove very beneficial, as it would increase the organic-matter and nitrogen content of the soil and thus aid in the retention of soil moisture and render available other plant foods in the soil. Deep plowing is also essential.

SIOUX FINE SANDY LOAM

The surface soil of Sioux fine sandy loam, to a depth ranging from 8 to 15 inches but averaging about 12 inches, is dark grayish-brown or very dark grayish-brown, friable, mellow fine sandy loam, of single-grained structure in cultivated areas. The subsurface soil is fine sandy loam which ranges in places from loam or heavy loam to sandy loam. There is generally some indication of a slight translocation of clay to this layer, which is finely granular but of indistinct structure. This layer is underlain, at an average depth of about 22 inches, by a brown, yellowish-brown, or yellow incoherent mixture of coarse sand and gravel. Some coarse gravel and small bowlders are also present. The subsoil is calcareous, containing limerock pebbles.

In areas along East Fork Des Moines River from west of Bancroft to the county line northwest of Seneca, the subsoil varies somewhat

from typical. Locally it is predominantly coarse and sandy, contains little or no gravel, and is noncalcareous. The only other variation of note is the outcropping of the gravelly substratum on the points of hills and breaks where the terrace slopes down to the first-bottom land. Such areas are local and are indicated by means of gravel symbols.

Sioux fine sandy loam occurs on flat or undulating terraces, from 5 to 30 feet above overflow, along East Fork Des Moines River and some of the larger creeks of the county. The area southeast of Whittemore along Lotts Creek is a flat outwash plain and grades, without any change in elevation, into the Webster soils derived from drift in position. Because of the openness and porosity of the subsoil, natural drainage is inclined to be excessive and over some areas is very excessive.

Although of comparatively small total extent, this soil occurs rather consistently along most of East Fork Des Moines River. The areas vary in width from a quarter mile to 1 mile, and in many places individual farms consist solely of this soil.

From two-thirds to three-fourths of this soil is under cultivation to the common field crops. General farming is practiced by most farmers, although grain farming is rather widespread. Corn is the most important crop, followed by oats. Some other small grains are grown to a small extent. Hay, mostly timothy with some timothy and clover, as well as wild hay, is an important crop. Crop yields are somewhat variable, corn yielding from 20 to 45 bushels to the acre, oats from 20 to 30 bushels, and hay from three-fourths to 1½ tons. Pasture lands support native grasses.

As this is a droughty soil, crop yields vary to some extent, depending on how the soil is managed. The lack of moisture during the dry months is undoubtedly the greatest limiting factor in crop production. On areas cropped continuously to corn and oats, there is apt to be a greater loss of moisture because of the loss of organic matter and the physical condition of the soil. Several factors in management will assist in lessening the droughtiness of the soil. These include plowing to a depth of 7 or 8 inches, the application of manures and crop residues, and the inclusion of a legume in a rather short rotation. Part of the legume crop should be plowed under as green manure. The use of manures will not only improve the water-holding capacity but will add plant food to the soil.

The gravelly substratum of this soil furnishes a very valuable supply of gravel for highway construction and railway-bed ballast.

SIOUX LOAM

The surface soil of Sioux loam is dark grayish-brown or very dark-brown friable loam to a depth averaging 12 inches but varying from 9 to 15 inches. The subsurface soil is brown loam, heavy loam, sandy loam, or loamy sand containing some coarse sand and fine bits of gravel. It grades, at a depth of about 24 inches, into a yellowish-brown or buff incoherent coarse sand-and-gravel substratum, containing some coarser gravel and small rocks, including limestone pebbles and other rocks crusted with lime. The virgin surface soil has a finely granular structure.

The total extent of this soil in Kossuth County is small. It occupies small areas on gravel terraces and outwash plains, particularly along East Fork Des Moines River. The surface is flat, and because of the openness of the subsoil drainage is generally somewhat excessive, except in years of favorable precipitation.

The common field crops are grown with fair yields. The soil responds well to the application of manure and to good farm practice and must be well managed to yield profitably. Deep plowing and a crop rotation, which includes a legume, should be a part of the system of management. This soil is more productive than Sioux fine sandy loam. The recommendations given for the management of that soil apply equally well to this.

FARGO SILTY CLAY LOAM

The surface soil of Fargo silty clay loam, to an average depth of about 14 inches, is black or nearly black silty clay loam of finely granular or fine nut structure. Below a depth of 8 or 9 inches the material in many places is heavier in texture than the upper part of the layer. The subsurface soil is drab or dark-gray clay which in many places is calcareous. This layer continues to a depth averaging 28 inches but varying from 24 to 34 inches. The next lower layer, which extends to a depth of several feet, is lighter drab or gray calcareous clay which is commonly finely mottled with gray and brown. The surface soil in cultivated areas appears to be less mellow than in virgin areas.

Probably the largest area of this soil occurs in section 20 of Cresco Township. This area is on a flat stream terrace and is wet and dotted with boggy spots. It would be unsuited to cultivation without artificial drainage. The surface soil in this area is mostly silty clay loam, but small areas varying from loam to clay are included as are also small areas in which fine gravel is mixed with the clay of the subsoil. Elsewhere in the county Fargo silty clay loam occurs in pond or lakelike depressions. The soil is scattered over the county in areas ranging in size from 10 to 70 acres, but the total extent is not large.

Areas of Fargo silty clay loam are flat or depressed, and the heavy subsoil makes drainage generally deficient. Not much of this soil is under cultivation, its chief use being as pasture or wild-hay land. Its fertility is high, however, and with sufficient underdrainage and proper management it would be a productive soil. It is comparable in many respects to the depressed areas of Webster silty clay loam.

The first requisite to improvement for cultivation is the establishment of drainage, but it is in places difficult to obtain an outlet for tile drains. This soil is rich in nitrogen and is better suited to the production of corn and hay than to the small grains, which tend to lodge. The use of some manure and the occasional growth of a leguminous hay crop would be desirable factors in the management of cultivated areas. On properly drained and handled areas, crop yields should compare favorably with those obtained on the Webster soils.

BUCKNER FINE SANDY LOAM

The surface soil of Buckner fine sandy loam, to a depth of 16 inches, is dark-brown fine sandy loam of single-grained structure. The subsurface soil consists of lighter-brown or yellowish-brown sandy loam. Considerable coarse sand and scattered gravel are found through the surface and subsurface soil. The concentration of this coarse material is greater in the lower layer, but it comprises only a small percentage of the material.

Buckner fine sandy loam occurs in only a few small areas, the largest of which are along East Fork Des Moines River. The areas occupy benches from 5 to 30 feet above the first bottoms. Topographically the soil is comparatively flat. High winds may cause a slight shifting of the surface soil, and a few thin billowy ridges are formed on the otherwise even surface.

Drainage is good or excessive in dry periods, as it is in all open sandy soils. Seasonal variations greatly influence crop yields. Acre yields on the average are slightly higher than on Sioux fine sandy loam, which differs from this soil chiefly in the presence of the lower gravelly subsoil layer. Buckner fine sandy loam is generally considered a better soil than Sioux fine sandy loam.

This soil is always sold with adjacent soils which comprise the larger soil unit of the farms. It has an approximate value ranging from $75 to $135 an acre.

The greatest need of this soil is more organic matter, which can be supplied by growing and plowing under green-manure crops and by making liberal applications of barnyard manure. This will increase production, check the tendency toward drifting, and increase the moisture-holding capacity of the soil, thus lessening danger from drought.

HANCOCK LOAM

Hancock loam, to a depth of 10 inches, consists of dark grayish-brown or almost black friable loam which contains much fine sand to a depth of 3 or 4 inches. The structure of the surface soil is finely granular. The subsoil is dark-brown heavy loam or silty clay loam which becomes lighter colored with depth. At a depth of 20 inches this grades into yellowish-brown clay loam which is, in places, calcareous near a depth of 3 feet.

There is considerable variation in this soil texturally, especially in the surface soil. Coarse sand and small particles of gravel are found in patches scattered over the surface. In a few small depressions, the surface soil approaches silt loam in texture. A few pockets of sandy loam or fine sandy loam occur in the subsoil.

This soil is not extensive. Small areas occur three-fourths mile east of Irvington at the back of the terrace bench on which the town is built, and in sections 9, 15, 16, and 22 of Springfield Township, along Blue Earth River. A few areas, too small to show on the map, are scattered along the larger creeks. The surface is nearly flat, but a few narrow, shallow ridges have developed on the bench along Blue Earth River. Drainage is adequate, except in a few low pockets.

This soil is all under cultivation. Crop yields compare favorably with those obtained on Webster loam, averaging only slightly less to the acre. The soil is mellow, easy to manage, and is high in natural fertility.

This soil comprises only a small part of the farms on which it occurs and is sold with associated soils.

WABASH LOAM

The surface soil of Wabash loam is very dark grayish-brown friable, mellow loam of single-grained structure. It is underlain, at a depth of about 15 inches, by lighter grayish-brown or dark-drab silty clay loam or clay loam. The next lower layer is gray or drab silty clay, heavier in texture than the layers above but containing some very fine sand. A few iron stains discolor this layer.

This soil occurs on the bottoms of East Fork Des Moines River and a few of the larger creeks of the county. The areas are flat or level, and natural drainage is fair or deficient. The soil is not important in Kossuth County because of its small total extent. It occurs in only a few areas ranging in extent from 10 to 40 acres. It is best suited to the production of wild hay or for use as pasture land. A few well-drained areas are under cultivation to corn, oats, and hay. Yields are very good under favorable conditions, but over most of the soil as it occurs here, they are uncertain.

Fertilizers are not in use on this soil, but the application of manure, deep plowing, with the turning under of an occasional clover crop would satisfactorily maintain productiveness.

WABASH SILT LOAM

The surface soil of Wabash silt loam is very dark grayish-brown or nearly black silt loam which extends to an average depth of 15 inches. The lower part of this layer, between depths of 10 and 15 inches, is in many places rather heavy silt loam. The subsurface layer, which continues to an average depth of 28 inches, is dark-drab silty clay loam or silty clay. The next lower material is drab or gray silty clay or clay which contains many incipient iron concretions and a few mottles of lighter gray or yellow and brown.

This is an extensive first-bottom soil and, with the silty clay loam of the same series and Lamoure silt loam and Lamoure silty clay loam, comprises the greater part of the bottom lands of the county. These soils occur along East Fork Des Moines River and smaller streams, and to some extent in very wet depressions in the upland. Areas of this soil are generally flat, and natural drainage is deficient in many places though on the more desirably situated areas it is adequate for cultivation.

The most important variation affecting agricultural value in this and in other bottom-land soils is the surface relief, with its attendant influence on drainage. Though in general the soil is level, considerable areas are somewhat billowy or irregular. The surface is broken by the remnants of former stream courses or old meanders, or, as in the case of ditched streams, the former channels and ditch dumps contribute to a further loss of cultivable land. On the rougher bottoms along East Fork Des Moines River and the larger creeks, such

as Black Cat Creek, there is considerable timber growth. Even if cleared, such areas would not make desirable farm land in many places. They are utilized for pasture, timberland, or the production of wild hay.

The principal crops grown on Wabash silt loam are corn and oats. Very little tame hay is produced. Crop yields are variable, ranging from low to high, depending on drainage, seasonal conditions, and the character of the particular area. The bottom-land soils are high in potential fertility, but unless they are favorably situated, are of desirable relief, and are carefully farmed crop yields are not high. Good farming practices on desirable areas, however, produce nearly as satisfactory yields as are obtained on the better upland soils of the county.

Fertilizers are not in common use, although manure is used to some extent. The application of manure and the occasional growth of a leguminous crop, part of which is used as green manure, would assist materially in the improvement of the soil. Ground limestone should be applied to correct acidity.

Drainage of this soil has been benefited in many places by means of open ditches or other types of improved drainage. The well-drained areas of bottom soils yield consistently but are somewhat more subject to seasonal fluctuations than are many of the upland soils. Over periods of years, however, they average as productive. In soils of this kind there are many gradations between the desirable productive areas and those which are not suitable for cultivation.

WABASH SILTY CLAY LOAM

The surface soil of Wabash silty clay loam is black or nearly black silty clay loam rich in organic matter. It ranges in thickness from 12 to 18 inches but averages 15 inches. The surface soil has a fine nut structure. The subsurface soil, which continues to an average depth of 28 inches, is drab clay, slightly stained with iron. The next lower layer consists of lighter-gray or drab clay, more commonly stained with iron and in places showing greater mottling of gray, brown, and yellow.

Wabash silty clay loam occurs in places along East Fork Des Moines River and most of the larger creeks of the county. Areas are prevailingly flat, although locally the relief may be uneven as a result of more or less of a succession of rises and depressions, between which there may be a difference ranging from 3 to 8 feet in elevation. Remnants of former stream channels and some of the depressions contain water the year around. Such areas rather generally support a timber growth and are used as pasture land. Most of the soil, however, is suitable for cultivation or the production of wild hay.

The natural drainage of this soil is fair or deficient. Locally some small parts of larger areas are so poorly drained as to be swampy. Drainage has been benefited in many places by open ditches and tile drains.

Wabash silty clay loam is one of the more extensive bottom-land soils of the county. Many areas along East Fork Des Moines River are under cultivation. Very few of the small, narrow stream bottoms are suitable for cultivation but are used for hay and pasture land. Timbered areas occur only in the bottoms along East Fork Des Moines River and some of its larger tributaries.

Corn is the principal cultivated crop grown on this soil. Very little small grain is produced. Some tame hay is grown, but there is a larger acreage of wild hay. Crop yields are somewhat variable, but on areas suitable for cultivation they are fair or high. The thoroughness of drainage is the chief factor causing variations in productiveness. Weeds are frequently a serious problem on the bottom-land soils, and great diligence is sometimes required to control them.

No commercial fertilizers are used on this soil. The application of manure would be very beneficial, as well as the plowing under of an occasional legume crop, especially if considerable corn is produced. Such treatment would greatly improve the physical condition of the soil, as well as add plant food. If alfalfa or sweetclover is to be grown, the soil should be tested for acidity and the proper quantity of lime applied to correct the condition.

Land values vary considerably, depending on the value of the soil for cultivation, as well as on location, improvements, and similar factors. This soil is generally sold with adjoining soils of greater value and extent.

LAMOURE SILT LOAM

Lamoure silt loam has a black or nearly black silt loam surface layer which averages 15 inches in thickness. Below a depth of 8 or 10 inches the material may range from heavy silt loam to light silty clay loam. The subsurface layer is dark-gray or drab silty clay which grades, at a depth of about 24 inches, into the next lower layer, consisting of gray calcareous clay mottled in places with gray or brown.

Lamoure silt loam occurs along the creek and river bottoms of the county and is one of the least extensive bottom-land soils. It is very similar to Wabash silt loam, differing in that the subsoil is sufficiently calcareous to effervesce with acid.

This soil is of very little importance in the county because of its small extent. The characteristics, value, productiveness, and recommendations for improvement given for Wabash silt loam apply equally well to this soil.

LAMOURE SILTY CLAY LOAM

Lamoure silty clay loam has a very dark grayish-brown or black surface soil averaging 17 inches in thickness but ranging in thickness from 14 to 20 inches. The subsurface soil is dark-drab silty clay or clay which grades, at a depth ranging from 26 to 30 inches, into gray or drab, mottled, calcareous clay.

This soil differs from Wabash silty clay loam in the character of its subsoil. Otherwise the two soils are practically identical. Lamoure silty clay loam occurs more extensively along the small, narrow stream and ditch bottoms than does Wabash silty clay loam. Lamoure silty clay loam also occurs in depressed sloughy areas on the upland, whereas none of the Wabash soil occurs in such places. In this position the soil is surrounded by members of the Webster and Clarion series. Lamoure silty clay loam is subject to inundation after heavy rains and in places supports a plant growth characteristic of wet, sloughy areas. These areas are used for pasture or wild-hay land, if they are not too wet.

The means of improvement and use given for Wabash silty clay loam apply also to this soil.

PEAT

Peat has a surface layer consisting of raw brown peat, which varies in thickness from 6 inches to several feet but averages between 16 and 18 inches. In some areas of peat thin laminations of soil occur throughout. The underlying material is almost everywhere a layer of black muck or mucky clay, which commonly rests on drab or gray calcareous clay.

Peat is an accumulation of undecayed organic matter consisting of plant roots, stems, and leaves. It occurs in depressions that were once filled with water and formed ponds or lakes. As each year's growth of plants died they fell to the bottom, where the water, excluding the air, prevented their decay. This resulted in an accumulation of organic matter from season after season of growth over long periods of years. When the water finally was removed there was left this surface layer of undecayed plants which is termed peat.

Although peat occurs in scattered areas over the county it is most extensive in the northern three-fourths. However, one area comprising about 170 acres occurs in Garfield Township. Except in what is locally known as Union Slough, where there are about 2,500 acres of peat, few areas of this material exceed 80 acres in extent, and the average is probably between 30 and 50 acres.

The peat beds are flat, and natural drainage is poor. Many areas, however, have been given good drainage by means of tiling.

Different crops are grown on peat with varying degrees of success. In general peat is not adapted to the production of the cereal crops, because of the lack of mineral material. On some reclaimed areas of peat a few crops of corn or other grain are obtained, after which little or no grain is produced. This is owing to the fact that a small quantity of mineral soil was admixed with the peat. The first few crops exhausted this supply, making the further growth of crops unsuccessful.

The productiveness of any particular peat area depends on several factors, first of which is drainage. The establishment of drainage is the first essential step in the reclamation of any area of peat or muck. Other influencing factors are the character of the peat, its thickness, the underlying material, and the stage of decomposition. Many areas of this material vary as to the admixture of mineral soil, which directly affects the productiveness. This mineral soil is blown or washed in from the adjoining fields of high ground. Shallow peat is more easily and quickly subdued and put in a productive state than are deep areas. The shallowness facilitates compacting and decomposition and makes it easier for crops to reach the underlying subsoil with their roots. Most of the areas of peat in Kossuth County are comparatively shallow, ranging in thickness from 6 to 24 inches. Peat in the area locally known as Union Slough is reported as being from 4 to 10 feet thick. Because of the thickness of the deposit there is little possibility of it being made profitable for grain production. Most of the peat in this county is underlain by a good clay subsoil, so that when the surface material is reclaimed there is a profitable underlying material for crops to feed on. Peat which has decayed sufficiently to resemble a muck is generally more quickly reclaimed than more fibrous areas.

Some special crops are generally considered to do well on peat. They thrive better on peat which has undergone some decomposition than on raw peat. Peat soils are generally well adapted to the production of hay, and a recommended mixture consists of timothy and alsike. This is also a good pasture crop, and from the viewpoint of the reclamation of the peat, pasturing will produce quicker results than cutting the crop for hay. The trampling of livestock has the desirable effect of assisting in compacting the peat. The use of very heavy rollers for firming the peat has met with considerable success. On most general Corn Belt farms a hay crop fits well into the system for a few years until the peat is suitable for grain production. Muck and fairly well-decomposed peat are well adapted to specialized crops such as onions, celery, potatoes, and sugar beets, but these crops involve considerable specialized labor. Although the yield of sugar beets on peat is generally high, the sugar content tends to be low and the beets are discriminated against by some refiners.

Commercial fertilizers are not in use on peat in Kossuth County. Their use is advantageous in some localities and possibly would be here. Tests, however, should first be made to determine their economic value.

MUCK

Muck, as it occurs in Kossuth County, is a black, smooth, loose, mellow mass of organic matter mixed with varying amounts of mineral soil. Like peat, it is derived from deposits of undecayed water-loving plants. Muck, however, has attained a more advanced state of decomposition than peat and represents a stage through which that material will pass in its ultimate disintegration. Areas of muck in the county vary in thickness from a few inches to several feet but average between 18 and 24 inches.

Muck occurs over the entire county but most extensively in the northern three-fourths. Like peat, it is found in the upland in sloughs or pondlike depressions which were once under water but which are now drained or subject to inundation only part of the year. The largest areas occur in Eagle and Grant Townships. Some of these areas are old sloughs which meandered from one section to another, and in the largest there are small islands composed of mineral soil.

In general, muck is more easily subdued and put under profitable cultivation than is peat. Muck has attained a more advanced stage of decay and in most places contains more of an admixture of mineral soil. In localities where labor is plentiful and there are markets to absorb specialized crops, such as potatoes, onions, and celery, muck farms are operated very profitably and the land has a high value. Such conditions do not exist in Kossuth County, however, as most of the muck areas are not sufficiently well improved and markets are not adequate for the profitable marketing of the crops.

In general the use of muck land for hay or pasture until it has attained a sufficiently productive state for the growing of grain crops is the most desirable utilization. In some places shallow areas of muck are already producing good grain crops and filling their place in the general cropping system of the farm. The use of commercial fertilizers on muck is not recommended until a test has been made to determine their practicability. Lime is not needed on muck and peat in this county, as they already contain this material.

ALKALI SPOTS

Small areas of soil occurring generally throughout the county are made unproductive by the presence of alkali. Individually they are not large nor seemingly of great importance, but collectively they comprise several hundred acres of unproductive land. The alkali spots occur in small depressions in the Clarion and Webster soils. They vary in size from a small fraction of an acre to several acres. The alkali deposits generally occur in a circle running around the edge of the depression, but in some of the more level areas they seem to be evenly distributed.

The alkali spots occur in pondlike areas in which water stood at one time. In passing through and over the ground on its way to these ponds the water took into solution various salts. As the ponds had no outlet and as the subsoil was impervious, the only way for the accumulated water to be removed was through evaporation. As evaporation progressed the salts, known as alkali, were thrown out of solution and deposited in the soil. As more salts were carried into the pondlike area, the concentration increased until it reached excessive proportions. When the soil is dry alkali is visible as a white powder on the surface. These salts in the soil are toxic to plant growth. Corn is particularly sensitive to them, and in affected areas grows only from a few inches to knee-high, is sickly yellow in color, and produces no grain.

The first step necessary in the reclamation of an alkali soil is the establishment of good underdrainage. Tile lines should be laid around the edge, as well as through the center, of the area if it is of appreciable size. These excessively large quantities of salts can be removed from the soil only by being washed out in the drainage water. Drainage will eventually accomplish this, but it generally requires several years' time. Certain soil treatments assist in counteracting the effect of the alkali and allow good crop growth before the actual removal of all the harmful salts. These benefits are only temporary and will have no permanent effect on the alkali present, which must actually be removed from the soil.

The application of rather large quantities of fresh manure, preferably horse manure, will assist greatly in growing corn on alkali ground. Many farmers have found it profitable to grow a crop of sweetclover, which will grow on alkali land, and plow it under as green manure. The following year corn grows well, even before the alkali has actually been removed from the soil. Most of the alkali in Iowa soils is an accumulation of excessive quantities of soluble carbonates, though some areas discovered in the last few years have showed an excess of nitrates.

SUMMARY

Kossuth County is in the north-central part of Iowa. The Minnesota State line forms its northern boundary. It is rectangular in shape and comprises an area of 983 square miles.

The southern one-fourth of the county is a level, flat plain. The northern three-fourths is undulating or gently rolling, though it is predominantly smooth.

The drainage of the county is carried by East Fork Des Moines River and its tributaries, except in the north-central part where drainage is through Blue Earth River and its tributaries.

Transportation facilities for the county are supplied by the Chicago, Milwaukee & St. Paul, the Chicago, Rock Island & Pacific, the Chicago & North Western, and the Minneapolis & St. Louis railway systems. Main highways are well graded and graveled. There are a number of rural churches in the county and schools are maintained at regular intervals, except in consolidated districts.

The climate is characterized by comparatively cold winters and warm summers.

Agriculture is practically the sole industry of the county. It includes the raising of corn, oats, and other small grains, hay, and sugar beets for the feeding of livestock or for sale as cash crops. Hogs, cattle, both beef and dairy types, and some sheep are raised.

Land values range from $50 to $225 an acre and average between $125 and $200. The average county valuation for taxation purposes is $60.42 an acre.

Crop rotations, other than a shifting of grain crops, are not in very common use. This is probably owing to the high natural fertility of the soil. Improvements and farm equipment are generally good.

The soils of the county are all dark colored and are developed from glacial drift under the influence of a grass vegetation. The principal upland soils are included in the Clarion, Webster, and Dickinson series. The second-bottom or terrace soils include members of the Sioux, Fargo, Buckner, and Hancock series. The first-bottom soils are grouped in the Wabash and Lamoure series. Peat and muck also occur in the county to a considerable extent. The Clarion and Webster soils are most highly prized for farming, though some of the second-bottom soils, if well drained and properly managed, are highly productive.

Small spots are affected by harmful concentrations of alkali salts. The salts must be washed away to make the areas permanently productive, but by careful management fair crops can be raised before the salts are entirely removed.

[PUBLIC RESOLUTION—NO. 9]

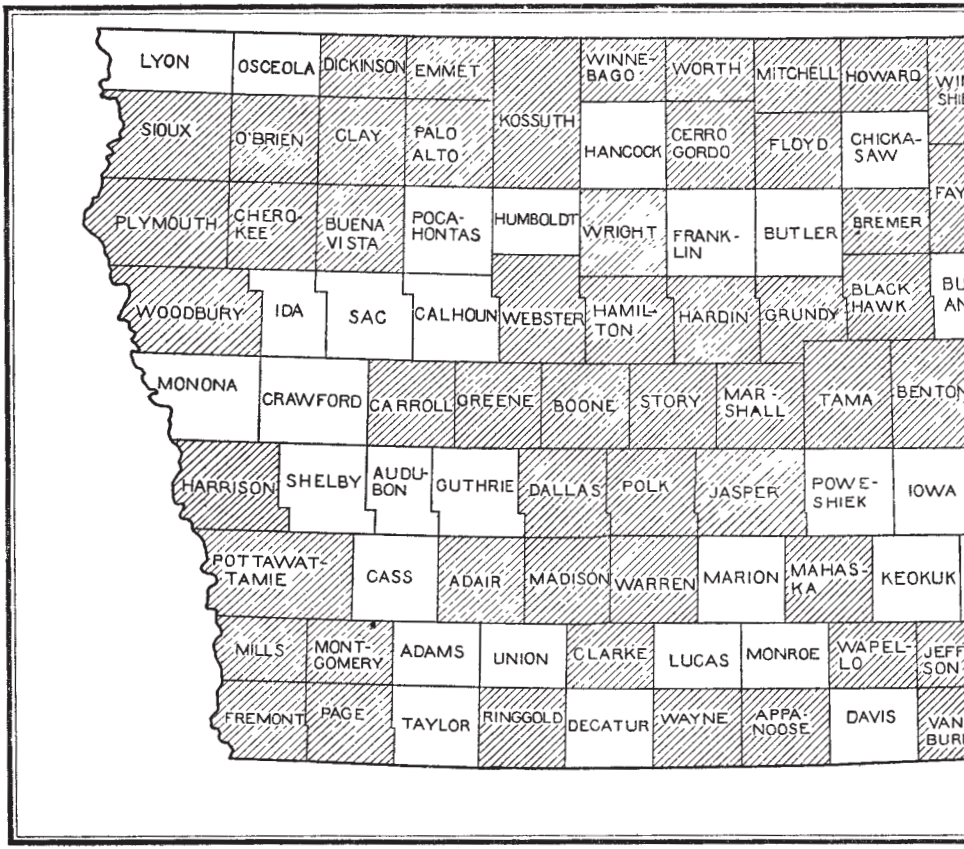
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Iowa, shown by shading

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
KOSSUTH COUNTY
IOWA

IOWA AGRICULTURAL EXPERIMENT STATION
C. F. CURTISS, DIRECTOR
W. H. STEVENSON, IN CHARGE OF SOIL SURVEY
P. E. BROWN, ASSOCIATE IN CHARGE

R. 30 W.
R. 29 W.
R. 28 W.
R. 27 W.
MARTIN CO.
KOSSUTH CO.
FARIBAULT CO.
MINNESOTA
IOWA
EMMET CO.
PALO ALTO CO.
WINNEBAGO CO.
HANCOCK CO.
HUMBOLDT CO.
BOUNDARY LINE
T. 100 N.
T. 99 N.
T. 98 N.
T. 97 N.
T. 96 N.
T. 95 N.
T. 94 N.
EAGLE
GRANT
SPRINGFIELD
HEBRON
SWEA
HARRISON
LEDYARD
LINCOLN
SENECA
GREENWOOD
RAMSAY
GERMAN
FENTON
BURT
PORTLAND
BUFFALO
LOTTS CREEK
UNION
PLUM CREEK
WESLEY
WHITTEMORE
CRESCO
IRVINGTON
PRAIRIE
GARFIELD
RIVERDALE
SHERMAN
LU VERNE
Swea City
Ledyard
Lakota
Bancroft
Fenton
Lone Rock
Burt
Titonka
Algona
Whittemore
Wesley
Irvington
Sexton
Hobarton
Rich Point
St. Benedict
Galbraith
Hanna
Lu Verne
St. Joseph
West Bend
Seneca
Plum Creek
County Home
Consolidated School
Originally Eagle Lake
Goose Lake
Burt Lake
DES MOINES RIVER
EAST FORK
Blue Earth River
Buffalo Creek
LEGEND
Buckner fine sandy loam Bf
Sioux fine sandy loam Sf
Clarion fine sandy loam Ca
Sioux loam Sm
Clarion loam C
Wabash loam Wo
Rolling phase
Wabash silt loam Wt
Dickinson fine sandy loam Df
Wabash silty clay loam Wa
Fargo silty clay loam Fc
Webster loam W
Hancock loam Hl
Webster silty clay loam Wc
Lamoure silt loam Ls
Muck Mu
Lamoure silty clay loam Ll
Peat P
CONVENTIONAL SIGNS
CULTURE
(Printed in black)
City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
Secondary roads and Trails
Railroads Steam and Electric
Bridges, Ferry
R.R. crossings, Tunnel
Ford, Dam
School or Church Cemeteries
Mine or Quarry Mine dumps Made land
Bluff, Escarpment Rock outcrop and Triangulation station
Stony and Gravelly areas
Soil boundaries
Boundary lines
Boundary lines
Boundary lines
U.S. township and section lines
RELIEF
(Printed in brown or black)
Contours Depression contours
Prominent Hills Mountain Peaks
Sand Wash and Sand dunes
Shore and Low-water line, Sandbar
DRAINAGE
(Printed in blue)
Streams
Lakes, Ponds, Intermittent lakes
Intermittent streams
Springs, Canals and Ditches, Flumes
Swamp Salt marshes
Submerged marsh Tidal flats
The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.
WILLIAMS & HEINTZ CO. WASH. D.C.

Thomas D. Rice, Inspector, District 3.
Soils surveyed by T. H. Benton, in charge, and D. S. Gray, Iowa Agricultural Experiment Station, and F. R. Lesh and J. E. McKeehen, U. S. Department of Agriculture.

Scale 1 inch - 1 mile
1 ½ 0 1 2 3 4 Miles

Field Operations
Bureau of Soils
1925